The impact of providing blood to the scene of an accident on transfusion laboratory practice

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Abstract

Background

Haemorrhage is the leading cause of death during trauma. In 2012, London's Air Ambulance introduced Blood on Board (BOB), transfusing group O red cells (RBC) to trauma patients at the scene.

Objectives

This study assessed the impact of BOB on: the number of mixed field samples received by the laboratory; the number of group O RBC transfused to non-group O patients; and the ratio of RBC to fresh frozen plasma (FFP) transfused in the initial 24 hours.

Methods

Three Major Trauma Centres collected data on patients for whom the major haemorrhage protocol was activated between August 2008-February 2012, pre-BOB, and March 2012-December 2013, post-BOB.

Results

233 trauma patients were identified pre-BOB and 119 post-BOB. There was no significant difference in the percentage of Group O units transfused to non-group O patients (75 vs. 82%, p=0.21) or the RBC:FFP ratio (pre-BOB mean 1.6 [IQR 1.0-2.0]; post-BOB mean 1.7 [IQR 1.1-2.2], P = 0.24). There was no significant difference in the percentage of mixed field samples received (23% v 27%, p=0.3).

Conclusion

The introduction of BOB did not change the proportion of group O RBC transfused or the RBC:FFP ratio, however, the proportion of acceptable samples decreased. This is largely due to an increase in blood samples not received from the post-BOB cohort, which we believe is probably due to patients who died at the scene. We have introduced robust systems to indicate reasons for not obtaining samples.

Introduction

Trauma is one of the world's leading causes of death, accounting for up to 5 **million** deaths per year (Haagsma et al, 2015). Uncontrolled post-traumatic haemorrhage is the leading cause of death in these patients (Cothren *et al*, 2007) and for this reason a timely and organised approach to the management of bleeding is crucial to improving clinical outcomes.

Observational studies in military and civilian trauma bleeding patients have indicated that transfusion of high ratios of plasma to red blood cells units (RBC) may improve morbidity and mortality although the quality of the evidence for this so far is low (Murad *et al*, 2010). The recent PROPPR trial showed a reduction in early exsanguination with a higher plasma to RBC ratio (Holcomb et al, 2015). Current guidelines therefore recommend that fresh frozen plasma (FFP) should be given upfront during major haemorrhage of trauma and that the initial FFP to RBC ratio should be 1:1 (Hunt et al, 2015). In order to allow for the early delivery of blood components during major haemorrhage, most hospitals have now established major haemorrhage protocols (MHP) as part of damage control resuscitation and studies have demonstrated that MHP improve administration of **blood components** and reduce wastage (Khan *et al*, 2013). Other measures, such as the use of tranexamic acid are also part of MHP to optimise haemorrhage control (Shakur *et al*, 2010).

In the pre-hospital setting, when compared to crystalloid resuscitation alone, early transfusion with RBC and plasma improves early outcomes although did not have an effect on 30-day mortality (Holcomb *et al*, 2014). However the impact of pre-hospital transfusion on laboratory practice is unknown. Blood transfusion prior to group and screen (G&S) testing may result in a mixed field reaction, requiring further testing, and in the case of urgent transfusion, the use of Group O units until investigations can be fully resolved (Milkins et al, 2013).

In March 2012, the London's Air Ambulance (LAA) started carrying Group O negative RBC for on-scene transfusion to trauma patients in an initiative known as Blood on Board (BOB). The aims of this study were to assess the impact of this on laboratory practice as examined by the number of mixed field samples received, the numbers of Group O RBC transfused to non-group O patients and the RBC: FFP ratios.

Methods

The London Trauma Network was established in 2008 to provide specialist and co-ordinated care to major trauma patients across the region, and to collect data for the purposes of audit and research. Patients are seen by LAA and then transferred to one of the designated major trauma centres. During the study period, these trauma centres used the same MHP. Group O units were given before **a** blood group was established. One hospital within the London Trauma

Network uses group O positive RBC units for male patients and group O negative RBC for female patients. The other trauma centres administer group O negative RBC for all patients. Data were collected from August 2008 to February 2012 (pre-BOB) and from March 2012 until September 2013 (post-BOB) on all patients for whom the MHP was activated. Data were collected from LAA trauma office records and hospital transfusion laboratories. Information obtained included demographic data, the number of RBC units transfused by LAA and destination of the patient (including death at the scene), and laboratory data, including group and screen results. The number of group-O and group-specific RBC transfused was recorded in addition to the number of other blood components issued in the first 24 hours from the time of arrival at hospital.

Group and screen samples

All group and screen (G&S) samples were taken in EDTA anticoagulated bottles and labelled with handwritten unique trauma identifiers according to hospitals' standard operating procedure. Samples were analysed as priority on arrival to the laboratory. Samples taken in the post-BOB group in patients who subsequently died at the scene were also taken to the laboratory.

ABO and RhD typing was determined by a microplate haemagglutination technique in Centre A (Immucor-NEO, Immucor Inc, GA, USA) and gel card technique in Centres B and C (**DiaMeD** ID-System, BioRad Laboratories, BioMed GbmH, Switzerland). Mixed field samples were defined as those whose blood

group could not be **resolved** by automation. For those patients who had a mixed field result detected by automation method, manual testing using the DiaMeD system was performed.

Inadequately labelled samples were defined as those where the sample did not meet the identification criteria required by the laboratory policy.

Statistical analysis

Statistical analysis was performed using Stata 12 software (StataCorp. 2011. *Stata Statistical Software: Release 12*. College Station, TX: StataCorp LPv). The results are expressed as mean, median, ratio and percentage. Comparisons between groups were made using the un-paired 'Mann-Whitney' test for not normally distributed data and t-test for normally distributed data. A 2-tailed p value of <0.05 was considered statistically significant.

Results

Between August 2008 and February 2012, we identified 352 patients in whom MHP was activated. Of these, 233 patients presented pre-BOB and 119 presented post-BOB. Their demographic data and blood **components** received are described in Table 1. The median age was 30 in the **pre-BOB group** (IQR 23-42) and 35 (IQR 23-51) in the **post-BOB group**.

In the pre-BOB group, 202 patients (87%) received a transfusion of any blood component. There was 100% traceability and no wastage. In the post-BOB group, 119 patients received a transfusion (100%) as part of BOB, and 83 patients (70%) received a subsequent transfusion of any blood **components** in hospital. Of the 36 patients not receiving any further transfusions after BOB, this included the 15 patients **who** died on the scene, but also 21 patients who did not require further transfusion in hospital.

Table 1. Demographics of patients and total amount of blood transfusion

		Pre-BOB N=233 (%)	**Post-BOB N=119 (%)**
Gender	Male	188 (81)	84 (71)
	Female	45 (19)	32 (27)
	Unknown	0 (0)	3 (3)*****
Age in years (IQR)		30 (23-42)	35 (23-51)
Destination	Trauma centres (total)	229 (98)	104 (87)
	- Trauma Centre A	171 (73)	77 (65)
	- Trauma Centre B	33 (14)	19 (16)
	- Trauma Centre C	25 (11)	7 (6)
	Died on scene	4 (2)	15 (13)**
Blood group	Known	201 (86)	80 (67)
	Unknown	32 (14)	39 (33)
	Group O (% of known)	93 **(46)**	37 **(46)**
	Non-group O (% of known)	108 (54)	43 (54)
Blood Components issued (range)			
Mean blood components transfused in first 24 hours per patient	Total RBC units	10 (0-67)	9 (1-63)
	-RBC given by LAA post-BOB	n/a	2 (1-4)
	FFP	6 (0-49)	5 (0-31)
	Cryoprecipitate	1 (0-17)	1 (0-17)
	Platelets	1 (0-10)	1 (0-6)

BOB: blood on board; IQR: interquartile range; RBC: red blood cells; FFP: fresh frozen plasma.

*** Due to rounding, the total % adds up to >100.**

**p<0.001

The mean (standard deviation) RBC to FFP ratio was 1.6 (0.8) in the pre-BOB group and 1.7 (0.8) in the post-BOB. There was no significant difference between the two groups (mean difference 0.13, 95% confidence interval 0.36–0.92). 59% of the pre-BOB patients and 42% of the post-BOB patients had an RBC to FFP ratio of 2:1 or less.

Results of group and screen samples (G&S) are described in Table 2. There was no significant difference in the percentage of mixed field samples pre-BOB vs. post-BOB (p=0.3).

Table 2. Group and screen samples

	Pre-BOB N=233 N (%)	**Post-BOB N=119 N (%)**
Mixed field	53 (23)	32 (27)
No sample received	30 (13)	**37 (31)**
Inadequate labelling	3 (1)	6 (5)
Acceptable	147 (63)	44 (37) *

*p < 0.001 (pre vs. post BOB)

BOB: blood on board

An analysis of group O units transfused to non-group O patients was performed and this is shown in table 3. There were 97 patients with a known non-Group O blood group who received a transfusion of RBC in the pre-BOB group and 43 in the post-BOB group. Patients who did not receive any transfusion were excluded

from analysis. The mean total number of RBC, mean total Group O units and the proportion of total units given as Group O are shown in table 3. There was no significant difference in the number of total RBC (p=0.17), number of Group O RBC (p=0.29) or the percentage of total units given that were group O (p=0.21). Patients were also categorised into those who received >95% of their total units as group O units or <95% group O RBC due to the wide range in the total number of units of RBC given and the difference in mean units given between the pre-BOB and post-BOB groups.

Table 3. Group O RBC transfused to non-group O patients in first 24 hours

	Mean total units RBC	**Mean Group O units RBC**	**Group O units/Total units (%)**
Pre-BOB N=97	**13**	**9**	**75**
Post-BOB N=43	**10**	**7**	**82**
	Group O units/total units <95%	**Group O units/total units >95%**	**Total**
Pre-BOB (N)	50	47	97
%	52%	48%	100%
Post-BOB (N)	25	18	43
%	58%	42%	100%

RBC: red blood cells; BOB: blood on board

Discussion

In this study we have shown that following the introduction of BOB, there has been no significant difference in the proportion of mixed field samples received by the laboratory (23% vs. 27%), suggesting that, post-BOB, G&S samples are being taken according to protocol, i.e. before transfusion. **In addition, we have demonstrated that there is no increase in the percentage of group O-units transfused to non-group O patients and no change in RBC: FFP ratios. These findings are reassuring as they suggest that BOB is safe, does not lead to increased usage of Group O units and is unlikely to significantly impact the laboratory workload.** Although there is a decrease in what is deemed an acceptable sample, it is likely that this is largely due to fewer G&S samples being sent from severely injured patients who died either at the scene of the incident or just before arrival in hospital in the pre-BOB era, as there would not have been an indication to send samples until arrival at the trauma centre. Other possible reasons for a decrease in acceptable samples include: failure to obtain G&S sample prior to initiation of blood transfusion at the scene of the incident post-BOB; inappropriate labelling of blood samples leading to rejection by the laboratories; or G&S samples being lost in the Emergency Department (due to chaotic nature of the situation) and not being sent to laboratories. We believe that the first reason is the most likely explanation, as the teams managing these patients both pre- and post- BOB have remained largely the same, although we note the small increase in inadequate labelling, which may be due to increased

workload at the scene, and this is being addressed with LAA teams. We note that results in mixed field results can vary depending on the technology used (UK NEQAS, 2016); however the technologies used were consistent in each centre across the course of the study and as the proportion of patient numbers from each centre was largely similar both pre-and post-BOB, we would not expect this to have significant impact on the proportion of mixed field samples received.

We also note the increase in number of patients recorded to have died at the scene; however due to the incomplete nature of the documentation, this was not always recorded and it is possible that this is an underrepresentation of the true figure, particularly in the pre-BOB group, as in the post-BOB group, death at scene was often recorded on the blood traceability form. This study was not powered to look for changes in mortality; however this is clearly something that needs further investigation in subsequent research.

It can be anticipated that the increase in unacceptable or missing samples would lead to an increase in the workload for transfusion staff (as there will be more frequent need to contact clinical teams to request another G&S sample), and this could have an impact on other valuable transfusion services. Ideally G&S samples should be taken at the time of intravenous cannulation by the LAA team prior to transfusion; however it is acknowledged that in some cases this will not be possible for clinical or practical reasons, and the priority must be early transfusion of blood **components.** Following the results of this study we have

introduced a G&S sample box which is sent to the laboratory together with the transfusion paperwork even in the event of patient death at the scene; if G&S sample is not taken, the clinical team must indicate the reasons for not including it.

Two important and interesting findings are those regarding the ratio of group O- units to non-group O patients, and the RBC: FFP ratios. There was no significant increase in the proportion of group O units issued to non-group O patients. The most likely reason for this is the availability and accessibility of remote issue for group O RBC units in emergency departments and operating theatres resulting in their high use both pre and post-BOB. In the acute setting, it is very likely that clinicians are not aware when patients can be switched to group specific RBC, and we are implementing systems to ensure that laboratory staff inform clinical teams when Group-specific blood is available, in order to reduce inappropriate transfusion of group O RBC. The ratio of RBC: FFP did not change between the two groups following the introduction of BOB. This is reassuring and can be explained by the fact that introduction of MHP in most trauma centres allows for FFP to be issued upfront, as soon as the major haemorrhage protocol is activated, and we are considering the introduction of thawed plasma to the BOB packs. Although the rate was higher than the current recommendation of 1:1, it is consistent with the then recommended ratio of 6:4 which was part of the MHP used at the time, and we expect it to change in light of the new guidelines.

In conclusion, BOB appears to have led to an increase in the proportion of unacceptable G&S samples. This is likely to be due to an increase in cases in which no sample was received (probably due to the capture of patients dying at the scene in the post-BOB cohort). However, the proportion of Group O RBC issued to non group O patients has not significantly increased; this is because almost half of non-group O patients in both the pre and post-BOB groups are receiving >95% group O RBC in the initial 24 hour period, even when patient's blood group is known. More work needs to be done to improve communication between pre-hospital and laboratory teams in order to optimise the quality of G&S samples received; this will enable patients to receive the most appropriate blood components as quickly as possible. The most efficient strategies for doing this need to be identified and the impact on laboratory and clinical outcomes measured. The BOB project is still in its early days; with increasing awareness and education this can be improved.

Acknowledgements

SW collected data and wrote the paper, JM provided statistical analysis, KK and LG designed the study, ML, TM, KF, JU, and SA collected data ·and LG wrote the paper.

Competing interests: the authors have no competing interests.

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